
NextGEN
Aviation Weather Research Program (AWRP)
Overview / Initial UAS Research
UAS Weather Workshop
July 19, 2016
FAA

Presentation Overview

- AWRP Mission
- Long history of success!
- A sampling of current AWRP research initiatives
- Current UAS Weather Initiative
- Challenges ahead

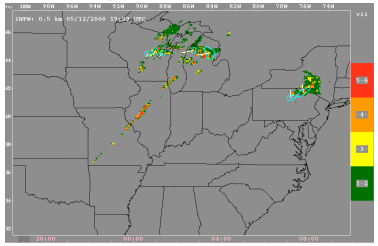
AWRP Mission

Applied research to minimize the impact of weather on the National Airspace System (NAS)

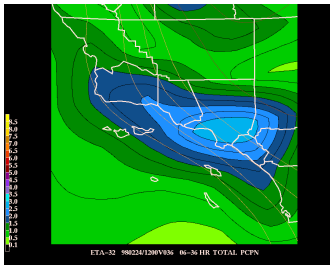
- The NextGen Implementation Plan contains specific initiatives to support NextGen weather Operational Improvements
- Collaborative, complementary initiatives with NWS to transition legacy capabilities to meet NextGen requirements
- Focused initiatives to help mitigate safety and/or efficiency issues associated with well-documented weather problems

AWRP 15+ Year History of Success

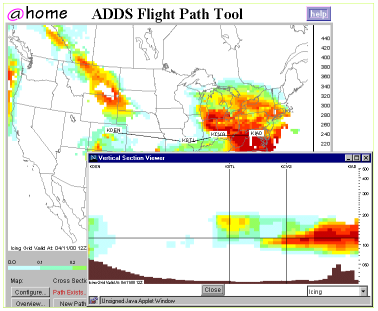
National Convective Wx Forecast, 2001



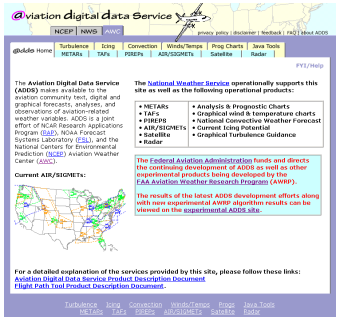
Rapid Update Cycle (RUC): 40KM, 1998; 20KM, 2002; 13KM, 2005



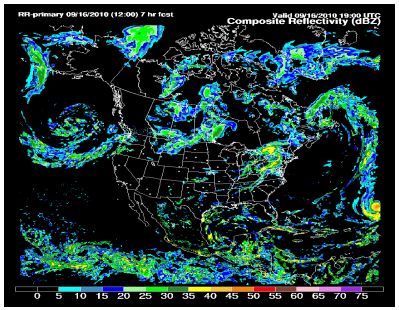
Current Icing Potential (CIP): original implementation, 2002; Forecast Icing Potential (FIP): original implementation, 2004; FIP Severity, 2011; CIP/FIP RAP, 2012; CIP/FIP High Resolution, 2014



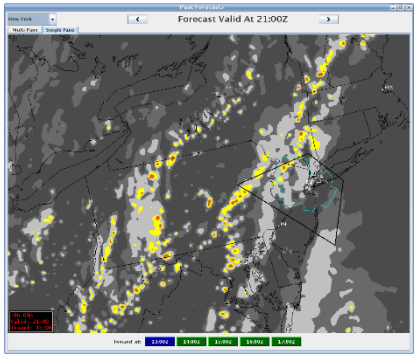
Aviation Digital Data Service (ADDS), 2003



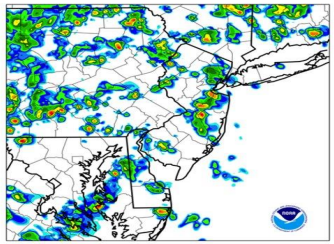
Rapid Refresh (RAP), 2012



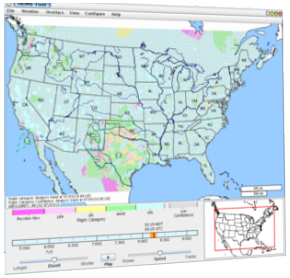
CoSPA, 2011



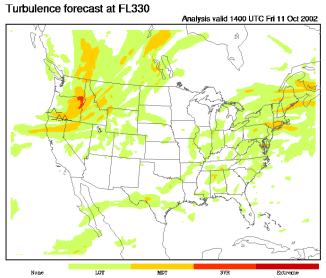
High-Resolution Rapid Refresh (HRRR), 2014



Helicopter Emergency Medical Services (HEMS): Initial Operation on ExADDS, 2007; Operational transition to ADDS, 2015



Graphical Turbulence Guidance (GTG): original implementation, 2003; GTG2 (Mid-Levels), 2010; GTG3 (Mountain Wave, Low Levels), 2015



A shout out to our fantastic partners!

NCAR | National Center for Atmospheric Research
UCAR | Atmospheric Research

National Science Foundation
NCAR IS SPONSORED BY THE NSF

MIT Lincoln Laboratory

NOAA Earth System Research Laboratory
Global Systems Division

MITRE

AvMet
Excellence in Aviation Weather

National Weather Service

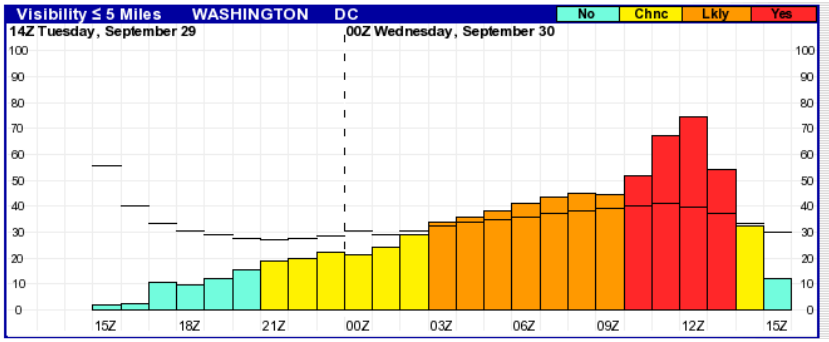
METRON AVIATION

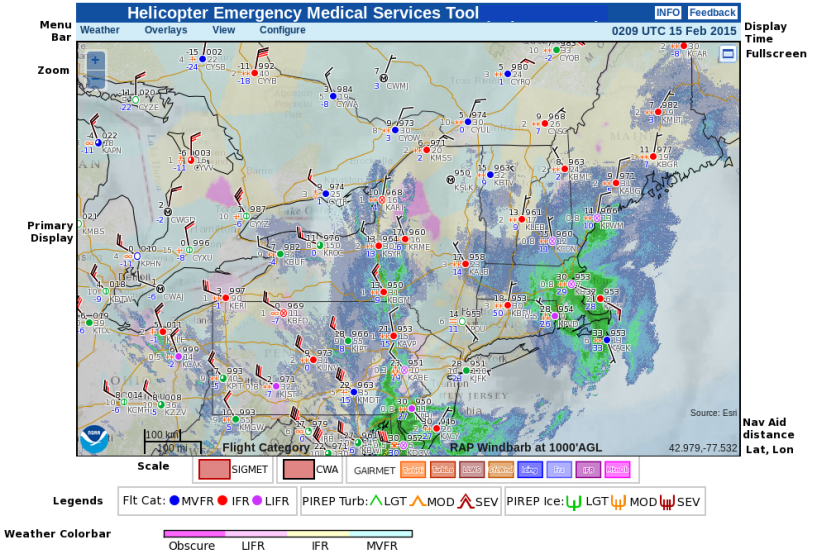
...and many more…

Federal Aviation Administration

Ceiling and Visibility (C&V)

- **Collaboration with NOAA to:**
  - Improve C&V analyses in the form of the Real Time Mesoscale Analysis (RTMA)
  - Improve Localized Aviation MOS Product (LAMP) forecasts
  - Test techniques for forecasters to enhance automated products
  - Integrate improvements into the Helicopter Emergency Medical Services (HEMS) tool, TAFs, and TRACON Area Forecasts



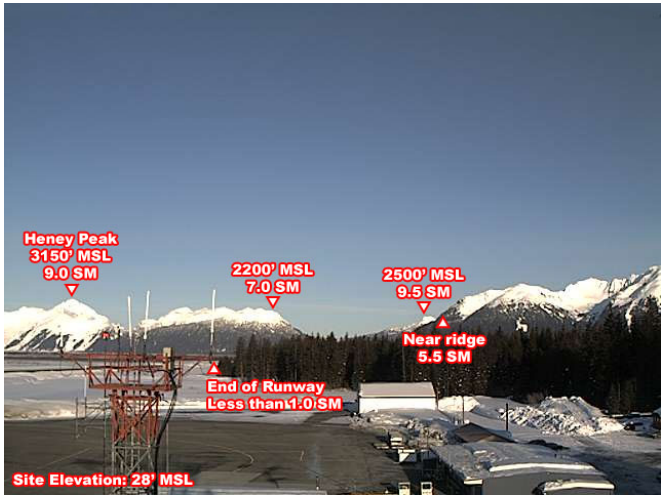


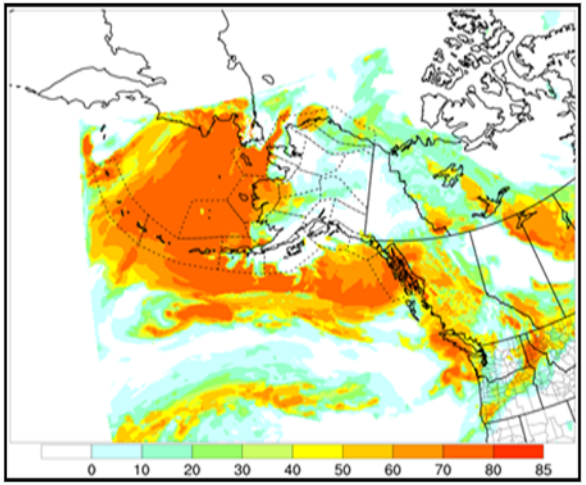
Alaska Specific Initiatives

- **Even with sophisticated weather applications in the cockpit, NTSB statistics show GA accident rates are not falling. Inadvertent VFR to IMC, especially in AK, still a big problem**
- **AWRP looking at specific applications to address GA accident issues in AK**
  - CONUS specific products such as GTG and CIP/FIP will not perform well over AK due to model resolution and available observational data
  - New products will leverage different data sets and better address forecast uncertainty
  - Critical need to improve first guess and analysis fields for many aviation impact variables

Alaska Specific Initiatives

- **Ceiling and Visibility Analysis for Alaska (CVA-AK)—collaboration with NCAR, MIT/LL and Alaskan Aviation Weather Unit (NWS) to:**
  - — Develop automated C&V analysis product combining surface observations and information from satellites and weather cameras
  - — Use as input for numerical model initialization
- **Icing Product Alaska**



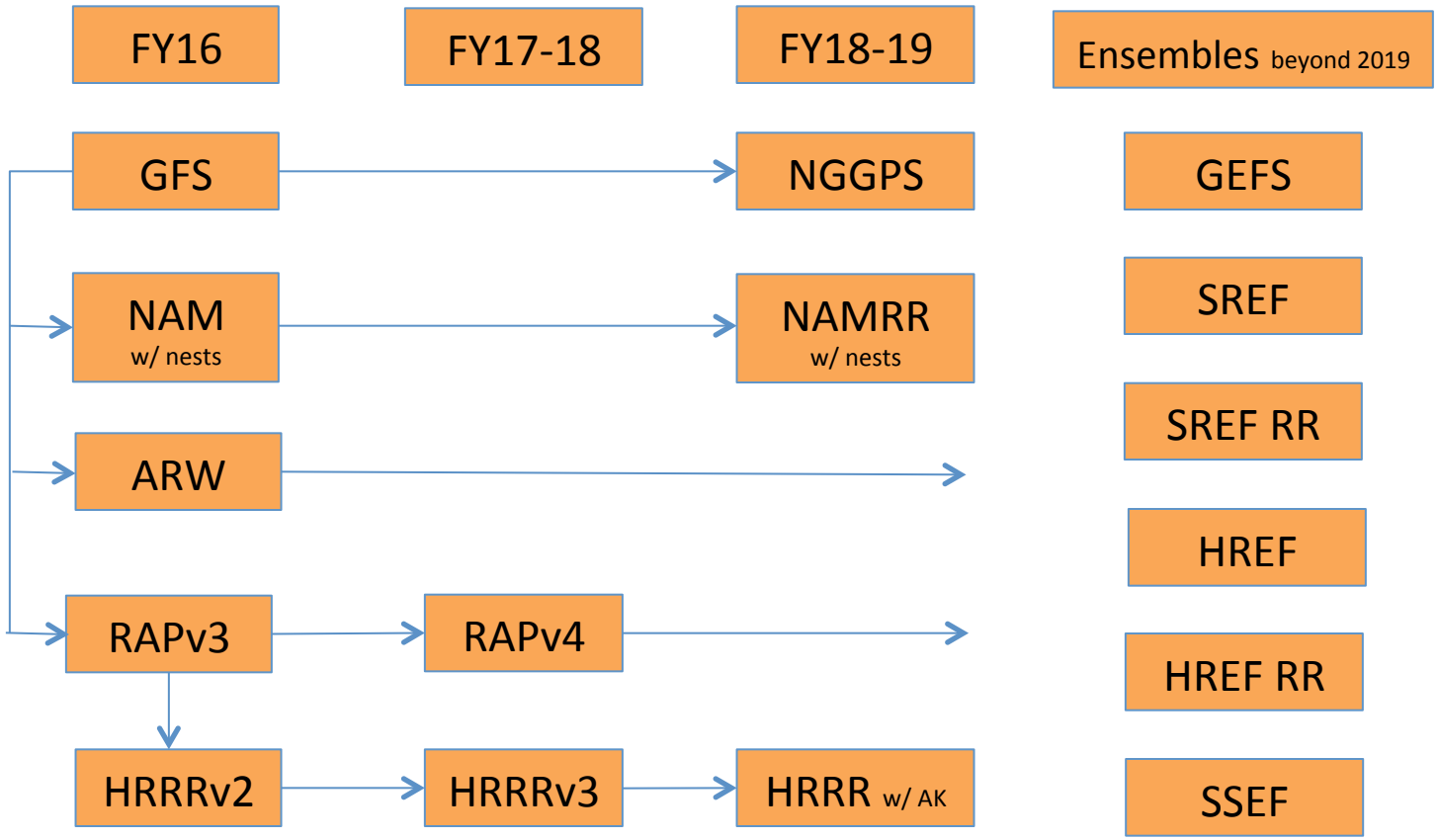


Numerical Modeling

- Supporting NOAA GSD efforts to improve model resolution, accuracy, and refresh rates via advancements in model physics, nested grids, and data assimilation on operational models
- Supporting research and evaluation of new modeling capabilities that have a viable path to NCEP operations including ensembles, global resolution improvements, and more…
- Developed and supported operational implementation of 3km High Resolution Rapid Refresh (HRRR) and RAP v2 at NCEP NCO
- Quantifying benefits of current and future model enhancements to the National Airspace System

Aviation specific research efforts funded at nearly $8 million over the last 5 years

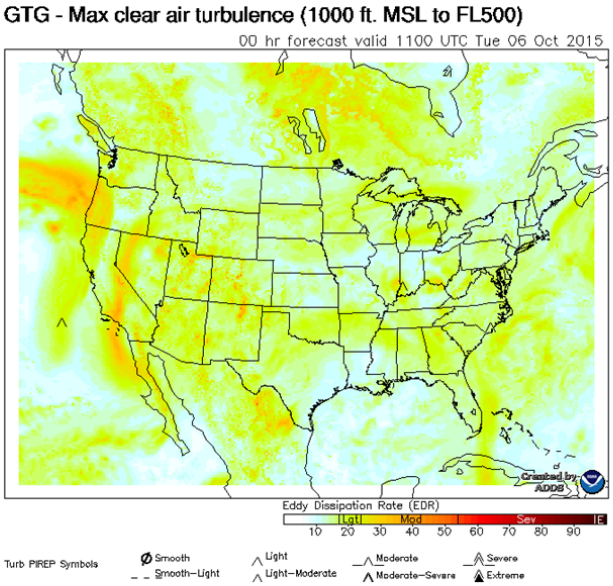
Timeline – NCEP Models

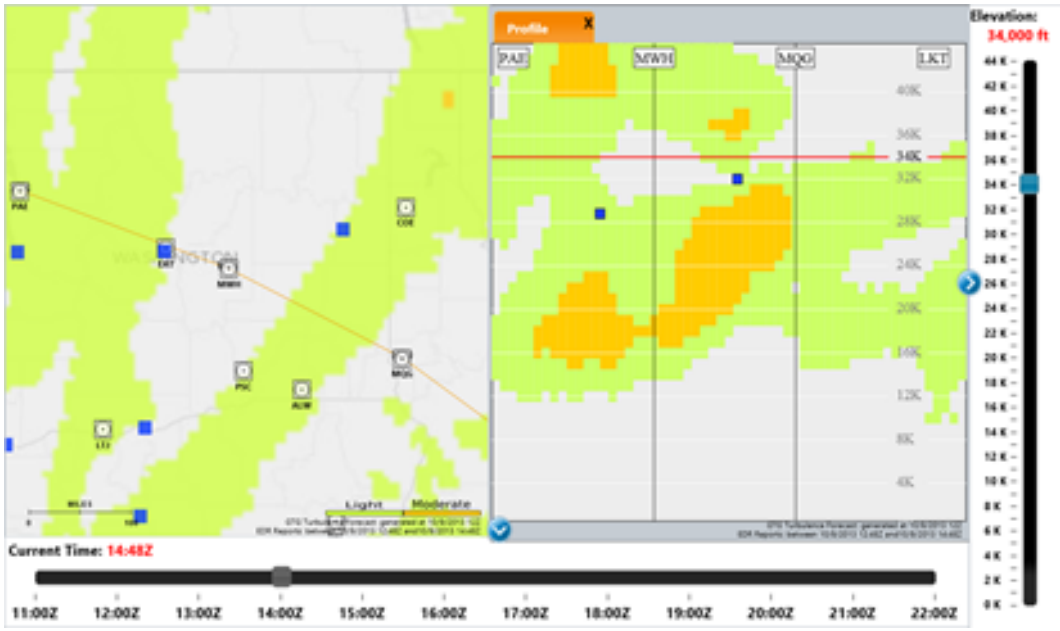


Turbulence

- Graphical Turbulence Guidance (GTG) upgrades include mountain wave turbulence and low level turbulence diagnostics. Operational on aviationweather.gov
- Develop and evaluate additional turbulence forecast capabilities including convectively induced turbulence (CIT), Alaska-specific and Global coverage products
- Research to enhance the operational capability to remotely sense turbulence (i.e., with satellites and radar)
- In collaboration with Delta Air Lines, provided dispatch and flight crew access to turbulence forecasts and EDR data for strategic and tactical decision making

Turbulence


GTG - Max clear air turbulence (1000 ft. MSL to FL500)
00 hr forecast valid 1100 UTC Tue 06 Oct 2015
Eddy Dissipation Rate (EDR)
Lgt
Mod
Sev
10 20 30 40 50 60 70 80 90
Turb PIREP Symbols
Smooth
Smooth–Light
Light
Light–Moderate
Moderate
Moderate–Severe
Severe
Extreme


Profile
PAE
MWH
MQG
LKT
Elevation:
34,000 ft
Light
Moderate
Current Time: 14:48Z
11:00Z
12:00Z
13:00Z
14:00Z
15:00Z
16:00Z
17:00Z
18:00Z
19:00Z
20:00Z
21:00Z
22:00Z

Convective Storms

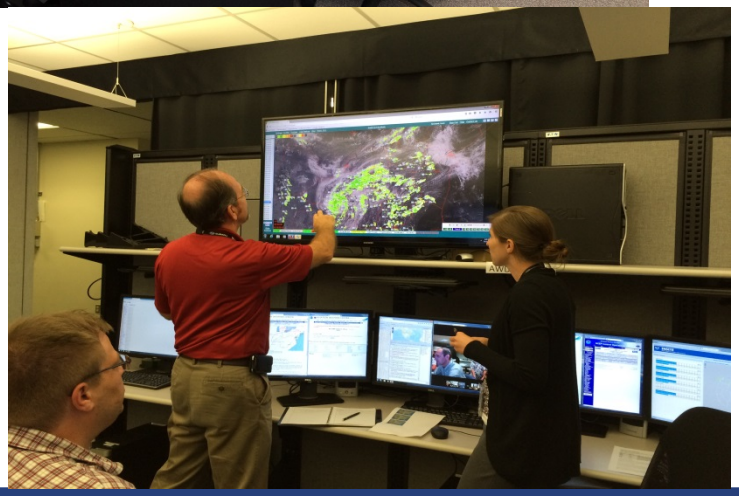
- Global-scale probabilistic convection forecast guidance out to 36 hours to support strategic planning of transoceanic flights in coordination with World Area Forecast Centers (WAFC)
- Increasing skill and continuity of 1–4 hour forecasts of VIL and echo tops by using new blending methods combining numerical weather model and extrapolation forecasts
- Refining techniques to improve the 0–6 hour prediction of convective initiation critical for NAS planning and operations
- Identified potential opportunities and key shortfalls associated with improved lightning threat awareness for airport operations

Collaborative work with FAA flight safety

- **High Ice Water Content (HIWC)**
  - Characterization of (HIWC) ice crystal environments that can be a threat to turbine engines
  - Diagnosis and forecasting of HIWC ice crystal environments
  - Assess and evaluate flight campaign data to determine modified current generation radar and new generation radar performance relative to avoidance of HIWC conditions ahead
- **Terminal Area Icing Weather Information for NextGen (TAIWIN)**
  - Responds to operational needs - new SLD Rule 25.1420 and NextGen capacity and throughput requirements in freezing precipitation
  - Develop capability/technology to manage impact of new certification SLD rule on terminal area operations; research on automated reporting systems and improved weather diagnostic/forecast tools
  - Flight campaign to acquire data from ground sensors, dual pol radar, numerical wx prediction models, and weather satellites

Aviation Weather Demonstration and Evaluation Services (AWDE)

- Core capability providing aviation weather demonstration and evaluation services
- Supports program managers with data to reduce programmatic risks, aids in the definition and validation of requirements
- Provides a laboratory capability to perform HITLs and other technical evaluations, often in collaboration with Aviation Weather Center Testbed
- Provides access to SMEs in Human Factors, Engineering, Meteorology, Computer Science and Aviation Users
- Integral role with AWC on Summer Experiment in August



UAS Weather Research

- **Currently, there is little understanding about weather information that would be most beneficial to support safe and efficient UAS operations.**
- **This research will provide a better understanding of:**
  - Weather information and capabilities that would be most beneficial for UAS operations
  - Research that is needed to refine existing weather products for UAS operations
  - New weather capabilities that should be developed for UAS operations
- **Research performers:**
  - MIT/LL

Research Questions

- What weather products and information are most beneficial to support safe and efficient UAS operations?
- What are UAS operators currently using for weather information, and how are decisions made?
- Should prioritized attention be given to larger UAS/UAV that will require integration of UAS and manned aircraft in the NAS, as compared to smaller UAV classes (1-5 pounds, and 5-55 pounds) which are typically standalone and restricted to Class G airspace)?
- How should weather use cases be prioritized? (Safety, impact on ATC operations, economic impact, government & military verses civilian)
- Focus on the current or future operating environment?

Research Approach

- Task 1 – Identify UAS Weather Stakeholders
- Task 2 – Build Catalog of UAS Types, Mission Types, and Weather Considerations
- Task 3 – Develop UAS Weather Use Cases
- Task 4 – Establish Preliminary User Needs for Weather Information to Support Safe and Efficient UAS Operations
- Task 5 – Identify Weather Information Gaps for UAS Operations
- Task 6 – Develop Proposed Research Roadmap

Schedule of Deliverables

Deliverable	Completion Date/ Due Date
✓ Identification of UAS Wx stakeholders	03/04/16
✓ Catalog of UAS types, mission types, and weather considerations	03/31/16
✓ Prioritized catalog of UAS weather use cases	05/31/16
Analysis on weather impacts and preliminary user needs	Aug 2016
Analysis on UAS weather capability gaps	Nov 2016
Research roadmap for weather product development	Dec 2016

UAS Weather Catalog

- **Mission catalog**
  - Identified specific missions, which comprise 6 general flight categories, i.e. altitude and trajectory
  - Identified missions span all 5 UAV weight/size classes

		UAS Class				
		1	2	3	4	5
Mission Class	Specific Mission	0-20 lbs, < 1200 ft. AGL, < 100 mph	21-55 lbs, < 3500 ft. AGL, < 250 mph	< 1320 lbs, < FL 180, < 250 mph	> 1320 lbs, < FL 180, any speed	> 1320 lbs, > FL 180, any speed
Low Altitude Hover	Bridge and Structure Inspection	■				
	Accident Scene Investigation	■				
	Aerial Photography	■				
	Media / Cinematography	■				
Low Altitude Loiter	Power Production Inspection	■	■			
	Agriculture (Crop Monitoring/ Management)	■	■			
	Agriculture (Aerial Application)	■	■			
	Search and Rescue	■	■			
	Traffic Monitoring	■	■			
	Snowpack Monitoring	■	■			
	Law Enforcement	■	■			
Mid Altitude Loiter	Surveying and Mapping			■	■	
	Border Patrol			■	■	
High Altitude Loiter	Environmental Research/Sampling					■
	Maritime Surveillance					■
	Communications (TV/Telephone/ Broadband)					■
Low Altitude Point-to-Point	Transportation Infrastructure Inspection	■	■			
	Oil & Gas Pipeline/Platform Monitoring	■	■			
	Power Distribution Inspection	■	■			
	Medical Sample Transport	■	■			
	Package Delivery	■	■			
High Altitude Point-to-Point	Cargo					■
	Oceanic Cargo					■

Survey Responses

Use Code	Mission Class	Mission Type	Survey Responses
L1	Low Altitude Hover (0-500 ft / 0-1 hr / 0-3 mi)	Accident/News Scene Investigation	2
		Aerial Photography / Imaging	34
		Agriculture (Crop	2
		Bridge and Structure	7
		Media / Cinematography	5
		Research & Development	6
		Search and Rescue	1
		Survey and Mapping	18
L2	Low Altitude Loiter (0-500 ft / 0-1 hr / 3-25 mi)	Agriculture (Crop Management)	1
L3	Low Altitude Point-to-Point (0-500 ft / 1-12 hr / 3-25 mi)	Package Delivery	1
		Sensing	1
		Surveillance / Reconnaissance	3
L4	Low Altitude Point-to-Point (0-500 ft / 1-12 hr / 25+ mi)	Railway Monitoring	1
M1	Mid Altitude Loiter (500 - FL250 / 1-12 hr / 25+ mi)	Border Patrol	2
		Research & Development	1
		Survey and Mapping	2
H1	High Altitude Point-to-Point (FL250+ / 1-12 hr / 25+ mi)	No survey responses	0
H2	High Altitude Loiter (FL250+ / 12+ hr / 25+ mi)	Maritime Surveillance	1

Use Case Selection

Use Case	Mission Class
Surveying and Mapping	(L1) Low Altitude Hover (0-500 ft / 0-1 hr / 0-3 mi)
Agriculture (Crop Monitoring/ Management)	(L2) Low Altitude Loiter (0-500 ft / 0-1 hr / 3-25 mi)
Package Delivery	(L3) Low Altitude Point-to-Point (0-500 ft / 1-12 hr / 3-25 mi)
Transportation Infrastructure Inspection	(L4) Low Altitude Point-to-Point (0-500 ft / 1-12 hr / 25+ mi)
Border Patrol	(M1) Mid Altitude Loiter (500 - FL250 / 1-12 hr / 25+ mi)
Cargo	(H1) High Altitude Point-to-Point (FL250+ / 1-12 hr / 25+ mi)
Maritime Surveillance	(H2) High Altitude Loiter (FL250+ / 12+ hr / 25+ mi)

- **Selection Criteria:**
  - Survey responses
  - FAA Pathfinder representation
    - CNN
    - PrecisionHawk
    - BNSF Railway
  - Alignment with FAA UAS ConOps

Upcoming Activities

- **Preliminary User Needs for Weather Information to Support Safe and Efficient UAS Operations – August 2016**
- **Identify Weather Information Gaps for UAS Operations – November 2016**
- **Develop Proposed Research Roadmap – December 2016**

Challenges

- **Uncertainty—**Complex challenges need to be better clarified regarding not only uncertainty attributes of weather products but also the ability of NAS/UAS decision makers to apply uncertainty information.
- **The Limits of the Science –** Realistically how good can we forecast within UAS operational paradigms. How good is good enough?
- **Integration**—translated weather information into decisions and decision support tools

Thanks for your support!

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